Weak antilocalization in topological insulator Bi$_2$Te$_3$ microflakes

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We have studied the carrier transport in two topological insulator Bi$_2$Te$_3$ microflakes between 0.3 and 10 K and under applied backgate voltages. Logarithmic temperature dependent resistance corrections due to the two-dimensional electron-electron interaction effect in the presence of weak disorder were observed. The extracted Coulomb screening parameter is negative, which is in accord with the situation of strong spin-orbit scattering as is inherited in the topological insulator materials. In particular, positive magnetoresistances in the two-dimensional weak-antilocalization effect were measured in low magnetic fields, which can be satisfactorily described by a multichannel-conduction model. Both at low temperatures of $T < 1$ K and under high positive backgate voltages, signatures of the presence of two coherent conduction channels were observed, as indicated by an increase by a factor of $\approx 2$ in the prefactor which characterizes the weak-antilocalization magnetoresistance magnitude. Our results are discussed in terms of the (likely) existence of the Dirac fermion surface states, in addition to the bulk states, in the three-dimensional topological insulator Bi$_2$Te$_3$ material [1].